Reliability and Validity of Knee Injury and Osteoarthritis Outcome Score (KOOS) in Iranian Population

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Abstract

Objectives: The purpose of present study was the investigation of reliability and validity of the knee injury and osteoarthritis outcome score in the Iranian population.

Methods: The method of the present study was non-experimental and methodological. The statistical population of the present study was patients with osteoarthritis of the knee. Patients with osteoarthritis of the knee referred to the Akhtar Center were selected from 127 people by available sampling for sample adequacy. In data analysis, Cronbach's alpha test to determine internal agreement, test-retest method to determine stability in reliability, item impact method to determine face validity, CVI and CVR indicators to determine content validity, and to determine structural validity two convergent and divergent validities as well as confirmatory factor analysis were used. Results: The results showed that if the fourth question "symptoms" is removed, the questionnaire has acceptable reliability and validity.

Conclusion: The analysis of the findings indicated that the Persian version of the questionnaire (KOOS) was a reliable tool for assessing the health status and impact of various treatments on patients with osteoarthritis in the country, which had high validity and reliability.

Keywords: KOOS, reliability, validity, osteoarthritis, knee injury

Introduction

Knee arthritis is one of the most common forms of osteoarthritis throughout the globe with higher prevalence among the middle-aged and older population. This disease is the most common disease of the synovial joints. Based on the studies, the prevalence of knee arthritis varied in 60–90% and 20% among people above 65 and 30, respectively.[1,2] The symptoms and disabling level of osteoarthritis deteriorate with aging, therefore, the high prevalence of knee arthritis and its related treatment costs will increase with the ever-rising aging of the population, imposing a huge economic burden. Osteoarthritis is a degenerative joint disease characterized by the gradual degradation of the cartilage. It can affect the weight-bearing joints such as the knee. Pain and physical disability are two major signs of knee osteoarthritis which can significantly influence the health and quality of life (QoL) of the patients.[3] Knee osteoarthritis has several symptoms such as pain, morning stiffness, and limited joint range of motion (ROM).[4,5] The process of aging involves degenerative, gradual, and irreversible changes in the systems of the body which can destroy the performance and life quality of the elderly.[6] Based on an estimation in 2004, 5 million Iranians suffer from this disease. This disease is one of the main causes of deficient performance, leading to extensive use of health insurance services. Long-term disability often significantly affects people's life including their mobility, independence, and daily activities, resulting in their social isolation, limited recreational, sport, and occupational activities, and hence the decline in their income.[7,8] Factors such as wrong dietary patterns and obesity prevalence in society, especially among women, have increased the rate of osteoarthritis. Wrong postures such as sitting on the ground and the use of a Pit latrine can also result in these complications. Knee osteoarthritis has increased in recent years not only among Iranian elderlies but also among the youth. Based on the studies, almost half of the adults will experience osteoarthritis in at least one of their legs by the age of 85, this risk is higher among the obese population.[9,10] Based on the advances, valid clinical tools are of crucial significance in the evaluation of the response to the treatment and deciding on the type of treatment. The researchers and physicians should have a proper evaluation of the clinical condition of knee osteoarthritis patients. Various tools have been developed to assess the QOL and performance of the knee osteoarthritis patients among which, Knee injury and Osteoarthritis Outcome Score (KOOS), short-form 36 (SF-36), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and Hip and Knee Questionnaire (HNQ) can be mentioned.[11] Although these evaluation tools have been developed in different countries, most of them originated from English and American literature. In this regard, the development of non-English tools is essential for cross-national and multi-central research and even assessment of the health condition of a country with different cultures and languages. Given the complexity of the mentioned structures, the tools developed in a country cannot be employed in another country just by translation. To adapt a tool to a different environment, in addition to translation, the cultural issues and traditions should be also adapted. The validity and reliability of the tool should be also evaluated.[12]

KOOS is one of the well-known and global tools to assess the consequences of knee injuries and osteoarthritis. This is a patient-oriented questionnaire to assess the disease symptoms and effects on physical activities and QoL.[13] KOOS is a specific tool for knee osteoarthritis and has been considered as a subsection of WOMAC designed to evaluate the QoL of younger and more active patients. Several validated versions of this questionnaire have been published in various countries.[14-16]

A useful HRQoL should be able to measure the important fields and health issues of a specific disease. These significant domains and issues may be different in different cultural and social backgrounds. KOOS questionnaire has been recently shown to assess many fields and domains. Numerous researchers such as Ackerman (2021),[17] Peer and Lane (2013),[18] and Bekkers (2009)[19] have also confirmed the validity and reliability of this questionnaire. KOOS questionnaire has been extensively utilized in English-speaking countries for the clinical assessment of the severity of the injury and improvement in the performance for monitoring the treatment outcomes. This tool is one of the disease-specific questionnaires with extensive application in various papers. It has been translated into 49 languages so far. To use this questionnaire for non-English-speaking patients, the questionnaire should be adapted in terms of cultural factors in addition to the translation. Its reliability and validity should be also evaluated. In this regard, the reliability and validity of this questionnaire were confirmed by various researchers including Roos et al. (1998)[15] in Sweden, Xie et al. (2006)[20] in Singapore, Roy et al. (2016)[21] and Zhang et al. (2019)[22] in China, Ranjan Kumar et al. (2021)[23] in India, Vaquero et al. (2014)[24] and Lizaur-Atilla et al. (2019)[25] in Spain, Chang et al. (2019)[26] in Hong Kong, Alfadhel et al. (2018)[27] in Saudi Arabia, Ateef et al. (2017)[1] among Ordo-speaking population, Paradowski et al. (2014)[28] in Poland, and Ornetti et al. (2008)[29] in France.

KOOS questionnaire includes 42 questions in five dimensions investigating 5 disease-related concepts including pain (9 questions), other disease-related symptoms (7 questions), daily activities (17 questions), sports and recreational activities (5 questions), and QoL related to the knee problems (4 questions). This questionnaire was designed and developed based on the Likert version and WOMAC questionnaire on a 5-option scale.[15] As mentioned, due to the complexity of structures, the questionnaire developed in a country cannot be applied in another country just by translation. The questionnaire should be customized in terms of cultural and traditional issues to be applicable in a different environment. For instance, the daily activities in the eastern and middle east communities require more extensive flexibility and range of motion which should be considered in the design of the questionnaire.[30] This research, thus, tried to assess the reliability and validity of the KOOS questionnaire in the Iranian population to offer a valid Knee Injury and Osteoarthritis Outcome Score (KOOS) evaluation tool. This study is aimed to translate and culturally adapt the KOOS questionnaire to Iranian culture and assess its reliability and validity in the Iranian population.

Research Method

This research was non-experimental and methodological. The translation was achieved by a forward and backward translation of the main English version of the questionnaire into Persian according to the available instructions. After translation of the questionnaire into English, it was presented to 5 experts in several stages. The questionnaire was finally confirmed after final evaluations and resolving the deficiencies of the translation as well as collecting the comments of the experts.

Population and Sample

The statistical population included knee osteoarthritis patients. Totally, 127 knee osteoarthritis patients referred to

Akhtar center were sampled by the available sampling method based on sample adequacy. The age of the participants ranged from 40 to 70; they referred to Akhtar Hospital within a two-month period. The questionnaires were presented to them after obtaining their written consent and providing them with a necessary explanation of the research process. The questionnaires were distributed in two stages. Once in the first session and then, two weeks after the first session to test the repeatability of the tests. After collecting the questionnaires in a 14-day period, the information of 127 questionnaires could be analyzed which was employed in the following.

Research Tool

KOOS is a questionnaire designed to detect the short-term and long-term consequences of knee injuries in patients. This questionnaire is a self-administrated test evaluating five consequences of pain, symptoms activities of daily life (ADL) function, sports and recreation function, and QoL. It also estimates the main indicators of the knee injury consequences which can be employed to assess the duration of the knee injuries and the treatment outcomes. Five aspects of the questionnaire are scored separately. The aspects of pain, symptoms, ADL, sports and recreation functions, and QoL have 9, 7, 17, 5, and 4 statements, respectively. Five-point Likert spectrum was employed for answering which varied from zero, representing no problem, to four indicating very severe. To interpret the scores, they were converted into a scale varying from 0 (severe knee problems) to 100 (no problem). This type of scoring is common in orthopedic and general scales. These scores indicated the percentage of the attained score.

Data Analysis Method

To determine the reliability, two aspects of reliability stability and internal consistency were employed; while the validity of the questionnaire was assessed based on face, content, and construct validities.

Research Findings

Demographic Information

The statistical population included 127 knee osteoarthritis patients referring to Akhtar hospital. More than half of the participants (51.1%) were 30–45 years old. 23.6% of them were younger than 30. 14.2% of the responders were older than 55 while the remaining 11.1% were in the age range of 55–64 years old. 63% of the responders were female and the remaining 37% were men. 73.3% of the responders had no regular sports activities while 26.7 % of them followed a regular sports activity regime.

Reliability of the Questionnaire

Reliability is defined as a degree of similarity of the results during a specific period under similar conditions and through a similar methodology which can be measured by repeatability and reproducibility. The reliability of the questionnaire was determined by internal consistency and stability of the reliability.

a) Internal Consistency

Internal consistency or internal stability of a questionnaire refers to the level of consistency between a group of items that measure a structure. Cronbach's alpha is the most common coefficient used to determine internal consistency. The reliability coefficient of 0.7 is a suitable value for a question to remain in the questionnaire. The higher the value of this coefficient, the higher the internal stability of the questionnaire. The alpha coefficient must be calculated to determine the internal stability when the Likert scale is used in the tool. In this research, SPSS software was employed to assess Cronbach's alpha whose results can be observed in the following figure (Gliem et al., 2005).[31]

As can be seen, the level of Cronbach's alpha was sufficiently high in all dimensions except for the symptoms. The Cronbach's alpha of the symptom dimension was lower than 0.7, reflecting the lack of internal consistency. Based on SPSS software, the S4 statement (do you feel wear or hear any additional sound upon moving your knee?) declined the Cronbach's alpha whose elimination incremented the amount of the Cronbach's alpha to 0.755 Table 1.

b) Stability of Reliability

The test-retest method was utilized to determine the stability of the reliability. In this method, a test is repeated twice under similar conditions in a fixed interval. The correlation between the two tests results is then determined as listed in the following Table 2.

Validity of the Questionnaire

In this research, the validity of the questionnaire was explored based on face, content, and construct validities as will be discussed in the continue.

a) Face Validity

The face validity searches for the answer to this question: is the appearance of the designed tool relevant to the aim of the research? Do the responders to the tool agree on the sentences and wording of the tool? Is the perception of the non-expert people (target group) the same as the perception expected by the researcher? Are the details and general aspects of the tool acceptable for the responders? (Drost, 2011)[33] the qualitative and quantitative methods can be employed to determine the face validity of the tool, here, the quantitative method was adopted using the item impact score. To this end, a five-scale Likert spectrum was considered for each item: completely important (score: 5), important (score: 4), moderately important (score: 3), a little important (score: 2), and not important at all (score: 1). The questionnaire was then presented to the target group (15 experts in the field of knee injuries) to determine the face validity. The face validity was then calculated by the item impact score after collecting the filled questionnaire:

$$\text{Item impact} = \frac{\Sigma\left(F \times \text{significance}\right)}{N}$$

The scores above 1.5 indicate the face validity of the question. The results revealed that all the statements had acceptable face validity.

b) Content Validity

The content validity generally seeks the answers to these questions: Does the designed tool cover all important and major dimensions of the concept understudy? Does the tool construct investigate the item it should explore? Are the details and general aspects of the tool acceptable for the relevant experts? To determine the content validity, both qualitative and quantitative methods can be utilized. The content validity

Table 1. Cronbach's alpha results

Dimension	Number of statements	Cronbach's alpha	Unconfirmed statement	Cronbach's alpha upon eliminating the statement
Pain	9	0.879	–	–
Symptoms	7	0.6442	S4	0.755
ADL	17	0.941	–	–
Recreational and sport activities	5	0.897	–	–
Knee injury-related QoL	4	0.827	–	–

Table 2. Correlation results of test-retest

Dimension	Test-retest correlation	Significance	Stability of the reliability
Pain	0.887	0.001	Desirable
Symptoms	0.823	0.000	Desirable
ADL	0.899	0.004	Desirable
Sports and recreational activities	0.976	0.001	Desirable
Knee problem-related QoL	0.989	0.001	Desirable

Correlation coefficients higher than 0.8 imply the stability of the reliability of the questionnaire.[32]
As seen, all dimensions had high stability of reliability.

can be quantitatively assessed based on the experts' comments or by calculating the content validity ratio (CVR) and content validity index (CVI).[34] To make sure on selecting the most important and correct content (necessity of the questions), the CVR can be used while CVI can be applied to make sure that the questions are designed in the best way to measure the intended content.[35] To this end, 15 experts were asked to comment on each item of the tool and determine whether it is necessary, useful but not necessary, or unnecessary. CVR can be determined by the following equation:

$$CVR = \frac{(ne - N/2)}{N/2}$$

In the above equation, *ne* denotes the number of evaluators who decided on the necessity or usefulness of the statement; while *N* represents the total number of the referrers or evaluators of a statement. Regarding the minimum CVR of the one-way Lawshe test and as the number of evaluators was 15, the minimum CVR of the questionnaire was 0.49 (Lawshe 1975).[36] CVI can be calculated after determining CVR. To this end, the evaluators should comment on the specificity, feasibility, and clarity of the items based on a four-scale Likert spectrum. To determine CVI, the experts were asked to determine the relevance of each statement to the following four-scale spectrum:

- Irrelevant,
- Requiring fundamental revision,
- Relevant but requiring revision,
- Completely relevant

CVI can be then calculated for each statement using the following equation:

$$CVI = \frac{number\ of\ the\ evaluators\ scoring\ 4\ or\ 3}{total\ number\ of\ the\ evaluators}$$

The statement will be rejected if CVI<0.7. The statement required revision for 0.7<CVI<0.79; while statements with CVI>0.79 were acceptable. Based on the Lawshe table, for a target group size of 15 people, the statements with CVR>0.49 are acceptable. The results indicated that CVR was acceptable for all variables. The CVI of all statements exceeded 0.79 indicating the acceptable content validity of all statements.

c) Construct Validity

The construct validity of a measurement tool indicates how much the tool evaluates a construct or a characteristic with a theoretical basis. In this research, the construct validity was determined based on three indices of confirmatory factor analysis, convergent validity, and divergent validity using Smart PLS software.

1. Confirmatory Factor Analysis

This method shows the extent of the proper choice of the measurement statements of a construct. This method, indeed, determines whether the questions of the questionnaire are properly selected to explore the relevant factor. Therefore, confirmatory factor analysis is a method to assess the validity of the questionnaire. It is also known as the construct validity or measurement model. The purpose is to make sure of the regular factor structure. The confirmatory factor analysis is used to make sure of the construct after identifying the statements for the major factors. The strength of the relationship between the dimension and statement is shown by factor load. factor load ranges from 0 to 1. Factor loads smaller than 0.3 show a weak relationship which can be neglected. Factor loads in the range of 0.3–0.6 are acceptable while those exceeding 0.6 indicate highly desirable strength. T-test (*t*-value) is utilized to assess the significance of the relationship between the variables. As significance is examined at an error level of 0.05, if the amount of the observed factor load was smaller than 1.96, the relationship is not significant.[37] Regarding the factor load results, the statement of S4 showed a low factor load (0.190) with a *t*-value<1.96, reflecting its insignificance. Therefore, S4 should be eliminated from the questionnaire.

2. Convergent Validity

Convergent validity is defined as a strong correlation between the question and its corresponding domain. This is indeed a quantitative measure indicating the internal correlation and cohesion of the statements of a dimension. For a high correlation between the factor loads, the questionnaire has convergent validity. This correlation is essential to make sure that the test evaluated what it must measure. The average variance extracted (AVE) and composite reliability (CR), as well as the convergent validity, are listed in the following Table 3.

Convergent validity refers to the correlation which measures the statements of a latent variable. in this regard, convergent validity indicates the internal correlation and cohesion of the statements of measure (variable). The questionnaire has convergent validity if it has a high correlation between the factor loads of the statement. Two scales of average variance extracted and composite reliability are required to determine the convergent validity. AVE shows the correlation between a construct (latent variable) with its relevant indices. Fornell and Larcker believed that convergent validity exists when

Table 3. **Average variance extracted, collective reliability, and convergent validity**

Dimension		AVE	CR	Convergent validity
Pain		0.524	0.907	Acceptable
Symptom	All statements	0.408	0.815	Unacceptable
	Without S4	0.506	0.843	Acceptable
ADL		0.532	0.950	Acceptable
Sports and recreational activities		0.710	0.924	Acceptable
Knee problem-related QoL		0.670	0.886	Acceptable

AVE>0.5. composite reliability is a measure to assess the internal fitting of the model. CR can be determined based on the internal consistency of the questions of each factor. The convergent validity exists if AVE>0.5, CR>0.7, and CR>AVE (Kulandaivelan et al., 2017).[37]

CR>0.7

CR>AVE

AVE>0.5

3. Divergent Validity

Divergent validity refers to the low correlation of the statements of a latent variable with other latent variables. Based on the method proposed by Fornell and Larcker (1981),[38] acceptable divergent validity is established when the AVE of each construct is higher than its shared variance with other constructs (i.e. square of the correlation coefficient of the constructs) in the model. In this way, acceptable divergent validity of a measurement model implies that a construct in the model has higher interaction with its indices rather than other constructs.[37] Based on Fernell and Larcker, divergent validity was once rejected considering all statements. The divergent validity of the questionnaire was, however, confirmed upon eliminating S4 Table 4.

To summarize, the reliability of the questionnaire was explored by the stability of the reliability (test-retest methods) and internal consistency (Cronbach's alpha). The results indicated that the questionnaire had proper stability of reliability. Concerning the internal consistency, four dimensions out of the five studied dimensions showed acceptable internal consistency. The dimension of symptoms, however, has Cronbach's alpha value below 0.7 which is unacceptable. Using SPSS software, the statement lowering the internal consistency was identified. The acceptable Cronbach's alpha was achieved after eliminating that statement. The validity of the questionnaire was also assessed based on face, content, and construct validities. The results indicated that all the statements had acceptable face and content validities. Concerning construct validity, convergent ad divergent validities, as well as the confirmatory factor analysis, were utilized. The confirmatory factor analysis indicated that statement S4 had a factor load smaller than 0.4 and a significance level below 1.96; thus, it must be eliminated from the questionnaire. In the same way, the convergent and divergent validity of the questionnaire were unacceptable in the presence of S4, whose elimination resulted in the confirmation of the convergent and divergent validities.

Discussion

In this research, the validity of the questionnaire was assessed using face, content, and construct validities. The item impact score of all questions exceeded 1.5, confirming the face validity of all statements. Concerning the content validity, the CVR of all variables was higher than 0.49 which is acceptable. Moreover, the CVI of all statements was higher than 0.79, indicating the acceptable content validity of all statements. To assess the construct validity, three indices of convergent and divergent validities, as well as the confirmatory factor analysis were employed. The confirmatory factor analysis indicated that S4 had a load factor below 0.4 and a significance level below 1.96, thus it was eliminated from the questionnaire. Similarly, the convergent and divergent validities of the questionnaire were confirmed upon withdrawing the mentioned statement. The results revealed the proper validation of the KOOS questionnaire among the Iranian population.

The reliability of the questionnaire was assessed based on the stability of reliability (test-retest method) and internal consistency (Cronbach's alpha). The results revealed a high Cronbach's alpha level for all dimensions except for symptoms whose Cronbach's alpha value was below 0.7, reflecting the lack of internal consistency in this dimension. Using SPSS software, the S4 statement was responsible for the low Cronbach's alpha value of this dimension. The Cronbach's alpha value of the dimension of symptoms rose to 0.755 after eliminating the mentioned statement. These results were in line with the Cronbach's alpha values obtained for AIMS, WOMAC, and Sweden versions of KOOS by Roos et al. (1998),[15] as well as the work of Saraeipour et al. in 2007.[39] The lack of internal consistency of the subscale of symptoms was also reported in the Spanish version presented by Lizaur-Utilla et al. (2019)[25] and the Sweden version developed by Roos et al. (1998)[15] which can be assigned to the problems in the main version of WOMAC (the basis of KOOS questionnaire) or imprecise grouping of the items on symptom subset.

The test-retest method was applied to determine the stability of reliability. The obtained coefficients were above 0.8 for all dimensions, confirming the stability of reliability. This implies that the KOOS questionnaire has high reliability among the Iranian population. The results of this research indicated that the Persian version of the KOOS questionnaire is a culture-compatible, valid, and reliable tool the same as its other versions in different countries presented by Roos et al.

Table 4. Divergent validity by elimination of the statement with weal factor load

Square of the correlation coefficient between the constructs	P	S	A	PS	Q	√AVE	Divergent validity
Pain (P)	1	0.656	0.665	0.693	0.716	0.723	Confirmed
Symptoms without S4	0.656	1	0.706	0.602	0.529	0.711	Confirmed
ADL (A)	0.665	0.706	1	0.709	0.713	0.729	Confirmed
Sports and recreational activities (SP)	0.693	0.602	0.709	1	0.729	0.824	Confirmed
Knee probelm-related QoL (Q)	0.716	0.529	0.703	0.729	1	0.818	Confirmed

As seen, the divergent validity was confirmed after the elimination of statement S4.

(1998),[15] Xie et al. (2006),[20] Roy et al. (2016),[21] Zhang et al. (2019),[22] Ranjan-Kumar et al. (2021),[23] Vaquero et al. (2014),[24] Lizaur-Utilla et al. (2019),[25] Cheng et al. (2019).[26] Alfadhel et al. (2018),[27] Ateef et al. (2018),[1] Paradowski et al. (2014),[28] and Ornetti et al. (2008).[29] As mentioned before, knee arthritis is one of the most prevalent forms of osteoarthritis worldwide. Pain and physical disability are two major symptoms of knee osteoarthritis with can significantly affect the health-related quality of life (HRQoL) of the patients. Osteoarthritis is also one of the most common types of arthritis in people older than 40. It is the most prevalent disease among the elderly whose prevalence is even higher than cardiovascular diseases, hypertension, and diabetes.

Conclusion

This study indicated that the Persian version of the KOOS questionnaire could be a useful tool in multi-purpose evaluation to help osteoarthritis patients. Thanks to its acceptable validity and reliability and proper evaluation, this questionnaire can significantly help the patients and therapists to assess different dimensions of the disease and its impacts on diverse aspects of life.

Conflict of Interest

None. ■

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